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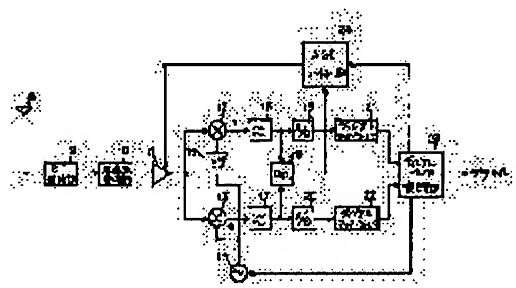
(54) DIRECT SPECTRUM SPREAD COMMUNICATION SYSTEM

(57)Abstract:

PURPOSE: To optimize the quantization level of an A/D converter by controlling the input amplitude level of the A/D converter according to the C/N ratio of a reception signal.

CONSTITUTION: Power amplification 9 is performed and branching is performed for the reception signal for which a frequency conversion 10 is performed after via an AGC amplifier part 11. Subsequently, the both signals are multiplied by the local sine wave signal that a 90° phase rotation is performed for the signal generated in a local sine wave signal oscillator 14 in a 90° phase device 15 an the local sine wave signal for which the phase rotation is not performed in multipliers 12 and 13, the signals pass through LPF 16 and 17 and orthogonal base band signals are generated. Next, reception power is obtained by a detection part 18 by using these both signals. An AGC control part 24 calculates a C/N ratio by using signal power and reception power, outputs a control signal to the amplifier part 11 adjusting the input amplitude of A/D converters 19 and 20 according to the obtained C/N ratio, controls the A/D input amplitude to an optimum value and realizes the best error ratio characteristic.



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CLAIMS

[Claim(s)]
[Claim 1] The 1st processing process which detects the 1st [of the following], and 2nd processing-process;CN (signal power pair noise power) ratio in processing of the receiving inside of a plane in the direct spread-spectrum communication mode which gets over in digital one, The direct spread-spectrum communication mode characterized by having 2nd processing-process; which sets the value of the quantization level to the input signal in an A/D converter as the value which suits the value of the CN ratio detected by the 1st processing process of the above.
[Claim 2] The value of the quantization level of the A/D converter in the 2nd processing process according to claim 1 is a direct diffuse-spectrum diffusion communication mode characterized by being set up with the value of the amplitude level of an input signal which suits the value of the measured CN ratio.
[Claim 3] The value of the quantization level of the A/D converter in the 2nd processing process according to claim 1 is a spread-spectrum communication mode characterized by being set up with the value of the reference level of the A/D converter to an input signal which suits the value of the measured CN ratio.
[Claim 4] The direct diffuse-spectrum diffusion communication mode characterized by setting the value of the quantization level to the input signal in an A/D converter as the quantization level value which suits each at the time of synchronous drawing in and synchronous prehension in the direct spread-spectrum communication mode which gets over in digital one.
[Claim 5] In the direct diffuse-spectrum diffusion communication mode which is asynchronous, and performs a recovery and is held in digital one The 1st processing process which detects the delta frequency of the 1st of the following, and the subcarrier between the 2nd processing-process; transmitter-receiver in processing of said receiving inside of a plane, The direct diffuse-spectrum diffusion communication mode characterized by having 2nd processing-process; which sets the value of the quantization level to the input signal in said A/D converter as the value which suits the value of the carrier frequency difference detected by the 1st processing process of the above.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to amelioration of a direct diffuse-spectrum diffusion communication link receiving set.
[0002]
[Description of the Prior Art] Generally the communication link which used narrow-band modulation techniques (AM (amplitude modulation), FM (frequency modulation), BPSK (2 phase phase shift keying), QPSK (4 phase phase shift keying), etc.) is used for the conventional data communication. Although these can realize the recovery in a receiver in a comparatively small circuit, they also have the fault of being weak, by the multi-pass or the narrow-band noise.
[0003] on the other hand, by diffusing the frequency spectrum of data (an analog and digital one -- whichever is sufficient) with PN (pseudo noise: pseudo-random) sign, and taking this PN code and a time amount synchronization (correlation) by the receiver side, a spread-spectrum communication mode has the description of mitigating the effect of a multi-pass and a narrow-band noise, and attracts attention as an important technique at the transmitting side.
[0004] There is a hybrid system which combined some of direct diffusion, frequency hopping, time amount hopping, and these in the technique of spectrum spread system, and it is the technique of diffusing a spectrum because a direct diffusion method carries out the multiplication of a PN code with a chip rate quite quicker than a data rate, and the data in this, and can realize easily compared with the technique of the others also in circuit, and multiplex communication in the same frequency band is attained by distinction of a PN code. Such multiplex system is called CDMA (Code DivisionMultiple Access: code division point-to-multipoint connection) or SSMA (Spread Spectrum Multiple Access: spread spectrum multiple access).
[0005] Moreover, after carrying out frequency conversion to a baseband band generally, an analog / digital conversion (A/D conversion is called a sampling and henceforth) is carried out, and all signal processing may be performed by digital processing. Thereby, the miniaturization of the baseband section and simplification are attained. Moreover, a digital matched filter is used in this case in many cases.
[0006] The block diagram of the outline of the spread-spectrum communication system using a direct diffusion method and a digital recovery method is shown in drawing 8 and drawing 9 . Drawing 9 is concerned with a receiving system here, drawing 8 concerning a transmitting system.
[0007] A transmitting system is first explained using drawing 8 . + The exclusive OR of the binary transmit data sequence which is expressed with 1 or 0 is carried out by the PN code (+ binary-code sequence expressed with 1 or 0) and EX-OR80 which were first generated in the PN code generating section 79. the sine wave by which the sequence acquired by this was generated with the sine wave generator 81 with the multiplier 82, and multiplication -- a BPSK modulation is carried out. After this, frequency conversion of this sequence is carried out to RF band in the frequency-conversion section 83, and power amplification is carried out in the power amplification section 84, and it is transmitted from the transmitting antenna 85. Thus, in this example, the BPSK modulation is used as an information

modulation. These actuation may be common and the common sending set for direct diffuse-spectrum diffusion communication modes may be used for it.
[0008] In a receiver side, as shown in drawing 9 , power amplification of the signal received by the receiving dish 86 is carried out by the RF amplifier 87, and it is changed into an intermediate frequency by the frequency-conversion section 88. Gain control of the signal changed into the intermediate frequency is carried out so that it may be inputted by the AGC (Auto Gain Control: automatic gain control) amplifier 89 with the optimal amplitude for A/D converters 96 and 97. It is separated spectrally two times after this, and the multiplication of the sinusoidal signal by which one side was generated by the local sine wave signal generator 90, and another side is carried out to the signal by which the phase shift was carried out about 90 degrees with 90-degree phase vessel 91 in this sinusoidal signal with multipliers 93 and 92, respectively, they pass along low pass filters 95 and 94, respectively, and are digital-value-ized by A/D converters 97 and 96. Supposing it uses BPSK, QPSK, etc. for the information modulation here and carries out a synchronous detection by the receiver side further, it is supposed that what is necessary is this A/D converter just to be a triplet grade. Thus, correlation is taken by the digital matched filter sections 99 and 98, it gets over by the digital phase recovery section 100 using the peak value, and the digitized input signal obtains data, respectively.
[0009] Moreover, signal power (a signal component and total received signal power which united the noise) is obtained using a bi-phase Seki output, and the AGC amplifier 89 is controlled by the AGC control section 101 so that this value becomes fixed. This AGC control section is realized here in the circuit generally shown in drawing 8 . The signal power obtained by the correlation signal is measured with reference voltage by the differential amplifier section 102. Then, the control signal which integrates with this difference signal by the loop filter section 103, and controls the AGC amplifier 88 is generated. This loop formation operates in the direction which makes equal to reference voltage signal power obtained by the correlation signal.
[0010] Thus, a communication link will be performed by wide band width of face by diffusing a spectrum, and a more effective communication link is attained to a multi-pass or a narrow-band noise. Fine tuning of the recovery section becomes unnecessary by furthermore being digitized (quantization), and a configuration also has simple and the merit of being miniaturized.
[0011] The spread-spectrum communication mode is stated to "spread-spectrum communication system" p10-p16 of technology publishing company issue in detail.
[0012]
[Problem(s) to be Solved by the Invention] If a digital recovery method is generally used, the circuits of the baseband section differ [simple and] in an error rate property very much by what level although miniaturized, A/D-converter input amplitude level is assigned to the maximum input electrical-potential-difference range of an A/D converter, and it is a signal power (power of only signal component) opposite noise power ratio (a C/N ratio is called henceforth.) before the optimum value correlating further. here -- the C/N ratio before the back diffusion of electrons -- expressing -- it differs, and the optimum value of A/D-converter input amplitude level becomes low, so that it will become low, if a C/N ratio becomes low. Therefore, even if it controls receiving signal amplitude only by the correlation peak signal, the optimal property has the trouble of not being obtained.
[0013] Moreover, in a frequency synchronization process, it is at the frequency drawing-in and prehension time, the optimum values of A/D-converter input amplitude level also differ, and the optimum value of A/D-converter input amplitude level has the trouble of becoming low, compared with the time of frequency prehension at the time of frequency drawing in.
[0014] Moreover, in having a frequency difference between transmitter-receivers which use differential detection etc., the optimal A/D-converter input amplitude level has the trouble that such optimal A/D-converter input amplitude level that a frequency difference is generally large in things becomes large, according to the frequency difference.
[0015] This invention aims at optimizing quantization level of an A/D converter in a direct diffuse-spectrum communication mode and a communication device.
[0016]

[Means for Solving the Problem] The input signal sampled and the A/D converter which quantizes, a means get to know received power, the quantized digital value and the digital matched filter section which takes correlation, and the amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter and the AGC control section which generates a gain control signal so that said A/D converter input amplitude level may be further optimized using the correlation peaking capacity of said matched filter and said received power, and controls an AGC amplifier constituted in the recovery method of this invention.
[0017] Moreover, the A/D converter which quantizes by sampling an input signal, and the quantized digital value and the digital matched filter section which takes correlation, The amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter, and the frequency synchronizer which computes a frequency control signal using the correlation peaking capacity of said matched filter further, and performs frequency synchronization, The gain control signal was generated so that said A/D-converter input amplitude level might be optimized based on a distinction means to judge frequency synchronization establishment, and its distinction result, and the AGC control section which controls an AGC amplifier constituted.
[0018] Moreover, it had a means to get to know noise power and signal power, and the frequency synchronization establishment distinction means, the gain control signal was generated so that A/D-converter input amplitude level might be optimized using both sides, and the AGC control section which controls an AGC amplifier constituted.
[0019] Or the input signal was sampled and the A/D converter which quantizes, a means to get to know received power, the quantized digital value and the digital matched filter section which takes correlation, the AGC (automatic gain control) amplifier that sets in the preceding paragraph and sets A/D-converter input power more nearly constant than an A/D converter, and the A/D control section controlled to optimize the reference level of said A/D converter using the correlation peaking capacity of said matched filter and said received power further constituted.
[0020] Or it had a means to get to know noise power and signal power, and the frequency synchronization establishment distinction means, and the A/D control section controlled to optimize the reference level of an A/D converter using both sides constituted.
[0021] Or the A/D converter which quantizes by sampling an input signal, and the quantized digital value and the digital matched filter section which takes correlation, The amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter, and a delta-frequency calculation means to generate the signal according to a delta frequency in case a differential recovery is further performed using the correlation peaking capacity of said matched filter, The gain control signal was generated so that said A/D-converter input amplitude level might be optimized based on the calculation result, and the AGC control section which controls an AGC amplifier constituted.
[0022] Or the input signal was sampled, and the A/D control section constituted so that the reference level of said A/D converter might be optimized based on the A/D converter which quantizes, the quantized digital value and the digital matched filter section which takes correlation, the AGC amplifier set in the preceding paragraph from the A/D converter, a frequency difference calculation means to generate the signal according to a delta frequency in case a differential recovery is further performed using the correlation peaking capacity of said matched filter, and its calculation result.
[0023] Or it had a means to get to know noise power and signal power, and the frequency difference calculation means, and the A/D control section controlled to optimize the reference level of an A/D converter using both sides constituted.
[0024] Moreover, it had a means to get to know noise power and signal power, and the frequency difference calculation means, the gain control signal was generated so that A/D-converter input amplitude level might be optimized using both sides, and the AGC control section which controls an AGC amplifier constituted.
[0025]
[Function] According to this invention, it amplifies, and frequency conversion of the input-signal s (t) is carried out, and it has an AGC amplifier let it pass after that. Then, the multiplication of the local sine

level of an A/D converter at this time. Therefore, gain must be adjusted by the above-mentioned AGC amplifier 11 so that an error rate may serve as min.
[0036] As for each digital value which is obtained here and which intersected perpendicularly, correlation is taken by the digital matched filters 21 and 22, respectively. A recovery is performed by the digital phase recovery section 22 in digital ones using the correlation peak acquired here. Moreover, a frequency error signal is generated using this correlation peak, and frequency synchronization can be realized by returning it to the criteria local sine wave generating section 14.
[0037] Moreover, the optimum value of the A/D-converter input amplitude level which makes an error rate min changes with C/N of an input signal as mentioned above. Therefore, it asks ~~for signal~~ power using the above-mentioned bi-phase Seki peak, and C/N of an input signal is computed by using with the received signal level computed previously, and the AGC amplifier 18 is controlled to optimize the A/D-converter input amplitude by the AGC control section 24. Calculation of signal power is IO U T and QO U T for example, about bi-phase Seki peak value here, respectively. Then, it asks by S= (IO U T 2+QO U T 2) 0.5.
[0038] The outline block diagram of the AGC control section is shown in drawing 3 . A C/N ratio is first calculated using signal power (the little noise is included in fact) and the received power obtained by the detection section 18. Thus, the optimal reference voltage is chosen and outputted by the information memorized in the ROM table 26 according to the obtained C/N ratio. Thus, the reference voltage and signal power which were obtained are measured by the differential amplifier section 27, and the control signal to the AGC amplifier 11 is further outputted through the loop filter section 28. The always optimal error rate property is acquired by this actuation.
[0039] Next, actuation of the transmitting system about the 2nd example is explained using drawing 4 . A point different here from the 1st example is a point of using the QPSK modulation for the information modulation.
[0040] The data sequence which should be transmitted first is divided into two data sequences by the serial/parallel-conversion section 29, and an exclusive OR is taken in the PN code sequence and EX-OR 30 and 31 in which each data sequence was generated by the PN code generating section 32. Thus, the multiplication of the sine wave in which one side was generated for the acquired sequence by the criteria subcarrier generating section 35, and another side is carried out to the signal which carried out phase rotation of the sine wave generated by the criteria subcarrier generating section 35 with 90-degree phase vessel 36 by multipliers 33 and 34, respectively. Thus, both the acquired signals are added by the adder 37, and a QPSK modulated wave is obtained.
[0041] Thus, frequency conversion of the acquired signal is carried out to RF band by the frequency-conversion section 38 like the 1st example, and power amplification is further carried out by the power amplification section 39, and it is transmitted by the transmitting antenna 40.
[0042] Next, a receiving system is explained. The outline block diagram of a receiving system is the same as that of drawing 2 used for the 1st example, and a different point has the digital phase recovery section 23 in drawing 2 in the point of performing a QPSK recovery rather than performing a BPSK recovery. Thereby, a data recovery is attained like the 1st example.
[0043] Next, the 3rd example is explained. The transmitting system uses the BPSK modulation for the information modulation like drawing 1 here.
[0044] Next, actuation of a receiving system is explained using drawing 5 . A point different here from the 1st example (drawing 2) is a point which added the frequency synchronization check section 57.
[0045] Power amplification of the signal received with the receiving antenna 41 like the 1st example is carried out by the RF amplifier 42, and frequency conversion is carried out to IF band in the frequency-conversion section 43. Level adjustment is carried out by the AGC amplifier 44 after this. This AGC amplifier 44 is like a previous example for keeping the optimal the input amplitude level of the A/D-conversion sections 52 and 53 of the latter-part baseband section, and especially the need of being put on this phase does not have it, and as long as it does not deviate from the meaning of this application, it may be put on other phases.
[0046] Thus, the acquired signal is separated spectrally two times, the multiplication of one side is

wave signal which intersects perpendicularly mutually is carried out, and an inphase and a rectangular baseband component are generated. Both [these] baseband signaling is digitized by one pair of A/D converters after this. Moreover, received power is obtained from both baseband signaling. Moreover, while correlation is taken by the digital matched filter and signal power is obtained from the bi-phase Seki peaking capacity, in the digital phase recovery section, a recovery is made using bi-phase Seki peaking capacity, and, as for both the signals by which the **** was digitized, data are obtained. Moreover, a best error rate property is realizable by controlling an above-mentioned AGC amplifier using the received power and signal power which were obtained previously to make an A/D-converter input level the optimal.
[0026] Moreover, a frequency synchronization detector is prepared and it detects whether frequency synchronization was performed here, and it is at the frequency drawing-in and frequency prehension time, an A/D-converter input level is changed, and the always optimal error rate property is realized.
[0027] Or the input power to an A/D converter is set constant by the AGC amplifier, and the same result is obtained by controlling the reference level of an A/D converter by the received power obtained previously and signal power.
[0028] Moreover, it is asynchronous, and when getting over, correlation is taken by the digital matched filter, a recovery is made by differential detection etc. in the digital phase recovery section from the bi-phase Seki peaking capacity, and data are obtained. Furthermore, the value according to the frequency difference between transmitter-receivers is acquired using these bi-phase Seki peak, and optimization or the reference level of an A/D converter is controlled for an A/D-converter input level according to it.
[0029] Or a best error rate property is realizable using together C/N obtained by the received power obtained previously and signal power by controlling control or the reference level of an A/D converter for an above-mentioned AGC amplifier to make an A/D-converter input level the optimal.
[0030]
[Example] The outline block diagram about the 1st example is shown in drawing 1 and drawing 2 . Drawing 1 expresses a transmitting system and drawing 2 expresses a receiving system here.
[0031] A transmitting system is first explained using drawing 1 . + The exclusive OR of the binary transmit data sequence which is expressed with 1 or 0 is carried out by the PN code (+ binary-code sequence expressed with 1 or 0) and EX-OR2 which were first generated in the PN code generating section 1. the sine wave by which the sequence acquired by this was generated with the sine wave generator 3 with the multiplier 4, and multiplication -- a BPSK modulation is carried out. After this, frequency conversion of this sequence is carried out to RF band in the frequency-conversion section 5, and power amplification is carried out in the power amplification section 6, and it is transmitted from the transmitting antenna 7. Thus, although the BPSK modulation is used as an information modulation in this example, unless it deviates from the meaning of this invention, other modulation means may be used.
[0032] Next, a receiving system is explained using drawing 2 . Power amplification of the input signal received with the receiving antenna 8 is first carried out by the RF amplifier 9, and frequency conversion is carried out to IF band by the frequency-conversion section 10. It is separated spectrally after going via the AGC amplifier 11 after that. It is for adjusting the input amplitude of latter A/D converters 19 and 20, there is especially no need for 11 AGC amplifier of being put on this location, and if it is the preceding paragraph of A/D converters 19 and 20, it will not be cared about anywhere here.
[0033] Then, the multiplication of the local sine wave signal by which phase rotation is not carried out with the local sine wave signal by which phase rotation was carried out to both signals about 90 degrees with 90-degree phase vessel 15 in the signal generated in the local sine wave signal oscillation section 14 is carried out with multipliers 12 and 13, respectively. The baseband signaling which intersected these signals perpendicularly by passing low pass filters 16 and 17, respectively is generated.
[0034] Received power is obtained by the detection section 18 using both [these] signals after this. This received power is used for control of the AGC amplifier 11 in the AGC control section 24.
[0035] Although both these signals are digital-value-ized by A/D converters 19 and 20, error rate properties differ by whether it is made to input with what amplitude to the maximum conversion input

carried out to the local signal generated in the criteria local sine wave generating section 47 with the multiplier 46, and the multiplication of another side is carried out with the local signal and multiplier 45 by which phase rotation was carried out about 90 degrees with 90-degree phase vessel 48 in the above-mentioned local signal, it passes along low pass filters 50 and 49, respectively, and is changed into the baseband signaling which intersected perpendicularly mutually.
[0047] Thus, power detection is carried out by the detection section 51, as for both the acquired signals, received power is measured, and the information on this detection result is sent to the AGC control section 58, and is used for control of the AGC amplifier 44.
[0048] Moreover, both the above-mentioned signals are digitized by A/D converters 53 and 52, respectively, and correlation is further taken by the digital matched filters 55 and 54, respectively. A BPSK recovery is made by the digital phase recovery section 56 using these bi-phase Seki peak, and a data recovery is performed. Furthermore, the power of a signal component is detected using the above-mentioned bi-phase Seki peak, and this signal is also sent to the AGC control section 58. Signal power S can be asked, for example by the above approaches here. It is used with the received power obtained previously, and a C/N ratio is called for and, thereby, it is used for control of the AGC amplifier 44. About this control, it is realizable by the same approach as ****. Furthermore, in the digital phase recovery section 56, the frequency phase error signal of a subcarrier is detected and a synchronous detection becomes possible by returning this to the criteria local sine wave generating section 47.
[0049] moreover, the above-mentioned frequency phase error signal is sent to the synchronous check section 57, frequency phase simulation draws now here, and it is a condition -- or it detects whether it is a seized condition, is the AGC control section 58 using this result, and is in a drawing-in condition -- or the AGC amplifier 44 is controlled to make A/D converter 52 and 53 input levels into the optimal condition according to whether it is a seized condition. Although the approach it is judged that synchronized when it became lower than the threshold which detects and has that detection power after letting the frequency phase error signal pass a synchronous symptom of this synchronous check section 57 and letting a high pass filter pass as an example here can be considered, it is not restricted to this example but what kind of technique may be used. It does not matter, no matter what approaches [, such as the general Costas loop formation about frequency phase error signal generation,] it may use.
[0050] The outline block section of the AGC control section is shown in drawing 6 . A point different here from drawing 3 is a point of having inputted the synchronization and the asynchronous acknowledge signal into the ROM table 60. C/N is calculated like **** using the signal power obtained with a correlation output, and the received power obtained by the detection section 51. Moreover, according to the synchronization and asynchronous acknowledge signal acquired as mentioned above, the contents of the ROM (responding to synchronous drawing-in condition or synchronous seized condition) table 60 are changed. And according to C/N obtained as mentioned above, the optimal reference voltage is outputted on the ROM table 60. Thus, the reference voltage and signal power which were obtained are measured by the differential amplifier section 61, and AGC amplifier 44 control signal is further outputted through the loop filter section 62. The always optimal error rate property is acquired by this actuation. from such information -- always -- an A/D-converter input level -- the optimal condition -- carrying out -- the best error rate property **** -- things become possible.
[0051] Moreover, if a QPSK demodulator is clearly used for the digital phase recovery section 56 in a receiving system using a transmitter like drawing 4 , QPSK as well as the 2nd example is usable.
[0052] Next, the 4th example is explained using drawing 7 . Here, a transmitting system explains actuation of a receiving system using the same BPSK modulation system as drawing 1 . A point different here from the 1st example is a point which removed the received-power detection section.
[0053] Power amplification of the signal received by the receiving antenna 63 is carried out by the RF amplifier 64 like the point, further, frequency conversion of it is carried out to IF band by the frequency-conversion section 65, and it is inputted into the AGC amplifier 66. The AGC amplifier 66 is for controlling the input amplitude of the latter A/D-conversion sections 73 and 74 so that an error rate property becomes the optimal, and does not have like **** the need of being placed here here.
[0054] It is distributed two times after this, and the multiplication of the sinusoidal signal with which

one side was generated from the local sine wave signal generator 69, and another side is carried out to the sinusoidal signal by which phase rotation was carried out with 90-degree phase vessel 70 by multipliers 68 and 67, respectively, a high frequency component is removed and they are changed into baseband signaling by low pass filters 72 and 71 further, respectively. It is digitized by A/D converters 74 and 73 after this, respectively, and correlation is taken by the digital matched filters 76 and 75.
[0055] In the digital phase recovery section 77, a phase recovery is carried out using each correlation peak of these. Moreover, in this phase recovery section 77, frequency error signal generation is carried out further, and frequency prehension is attained by returning this to the local sine wave signal generator 69 at frequency drawing in and a list. Moreover, the C/N ratio (processing gain is converted) of an input signal is obtained from signal power and its distribution using a correlation peak. The AGC amplifier 66 is controllable by using this in the AGC control section 78. It is realizable with the configuration which removed C / N operation part 25 from drawing 3 , and therefore, by this example, since the AGC control section 78 also removes the detection section 18 as compared with the 1st example, the miniaturization of it is attained more here. By changing a transmitting system into the QPSK modulator of drawing 4 clearly, and changing the BPSK demodulator of 69 in drawing into a QPSK modulator further, also when a primary modulation is considered as a QPSK modulation, it can respond.
[0056] Moreover, the frequency synchronization check section mentioned as this example in the 3rd example is prepared similarly, it is at the frequency drawing-in and frequency prehension time, and the same effectiveness as the point is acquired by changing an A/D-converter input level.
[0057] Moreover, it can respond also to DPSK and DQPSK by making a primary transmitting-side modulation into differential phase shift modulation in the example of all above, and making the receiving-side digital phase recovery section into the digital differential phase shift recovery section.
[0058] Next, the 5th example is explained using drawing 11 . Here, a transmitting system explains actuation of a receiving system using the same BPSK modulation system as drawing 1 . A point different here from the 1st example is a point of controlling the reference level (the signal input range of an A/D converter) of an A/D converter rather than controlling an AGC amplifier by C/N.
[0059] Power amplification of the signal received by the receiving antenna 104 is carried out by the RF amplifier 105 like the point, further, frequency conversion of it is carried out to IF band by the frequency-conversion section 106, and it is inputted into the AGC amplifier 107. The AGC amplifier 66 does not have like **** the need of being placed here here, although it is for seting constant input power of the latter A/D-conversion sections 115 and 116 and the use purpose differs from the above-mentioned AGC amplifier.
[0060] it is distributed two times after this and the sinusoidal signal with which one side was generated from the local sine wave signal generator 108, and another side carry out multiplication to the sinusoidal signal by which phase rotation was carried out with 90-degree phase vessel 109 with multipliers 110 and 111, respectively -- having -- further -- respectively -- low pass filters 112 and 113 -- therefore a high frequency component is removed and it is changed into baseband signaling. Received power is obtained by the detection section 114 using both the signals that these-intersected perpendicularly after this, further, both signals are digitized by A/D converters 115 and 116, respectively, and correlation is taken by the digital matched filters 117 and 118.
[0061] In the digital phase recovery section 119, a phase recovery is carried out using each correlation peak of these. Moreover, in this phase recovery section 119, frequency error signal generation is carried out further, and frequency prehension is attained by returning this to the local sine wave signal generator 108 at frequency drawing in and a list. Moreover, signal power is obtained using a correlation peak. The reference level of A/D converters 115 and 116 is controllable by the A/D control section 120 using this signal power and previous received power. The A/D control section 120 is realizable with a configuration as shown in drawing 12 here. Actuation of the A/D control section 120 is explained using drawing 12 . C/N is obtained by the C/N operation part 121 by the received power and signal power which were obtained first. C/N obtained here is inputted into the ROM table 122, can output the optimal A/D-converter reference level (here, the maximum (VIH) of the signal input range of an A/D converter and the minimum value (VIL) are expressed) according to C/N, can change this into analog voltage with

D/A converters 123 and 124, and can acquire the optimal property in inputting these into the reference input of A/D converters 115 and 116. Moreover, the control approach used for this example prepares similarly the frequency synchronization check section which could apply also to the 2nd example only by making the digital phase recovery section 119 into the QPSK recovery section, and was mentioned as this example in the 3rd example, it is at the frequency drawing-in and frequency prehension time, and the same effectiveness as the point is acquired by changing A/D-converter reference level. Moreover, it is possible to exclude the detection section 114 like the point by not using the detection section, in case C/N is obtained like the 4th example, but computing by correlation peak value and its distribution. The A/D control section in this case can consist of forms where C/N operation part was excluded from the configuration of drawing 12 .
[0062] Moreover, it can respond also to DPSK and DQPSK by making a primary transmitting-side modulation into differential phase shift modulation in the example of all above, and making the receiving-side digital phase recovery section into the digital differential phase shift recovery section.
[0063] Next, the 6th example is explained using drawing 13 . Here, a transmitting system explains actuation of a receiving system using the same BPSK modulation system as drawing 1 . A point different here from the 1st example is a point of not performing frequency synchronization.
[0064] Power amplification of the signal received by the receiving antenna 125 is carried out by the RF amplifier 126 like the point, further, frequency conversion of it is carried out to IF band by the frequency-conversion section 127, and it is inputted into the AGC amplifier 128. The AGC amplifier 128 is for controlling the input power of the latter A/D-conversion sections 136 and 137 the optimal, and does not have the need of being put on this location like **** here.
[0065] It is distributed two times after this, and the multiplication of the sinusoidal signal with which one side was generated from the local sine wave signal generator 129, and another side is carried out to the sinusoidal signal by which phase rotation was carried out with 90-degree phase vessel 130 by multipliers 132 and 131, respectively, a high frequency component is removed and they are changed into baseband signaling by low pass filters 134 and 133 further, respectively. Received power is obtained by the detection section 135 using both the signals that these-intersected perpendicularly after this, further, both signals are digitized by A/D converters 137 and 136, respectively, and correlation is taken by the digital matched filters 139 and 138.
[0066] In the digital differential phase shift recovery section 140, differential detection is carried out using each correlation peak of these. Moreover, the delta frequency of the subcarrier between transmitter-receivers is obtained by seeing the phase contrast between symbols in this phase recovery section 140. Moreover, signal power is obtained using a correlation peak. C/N is obtained using this signal power and previous received power, and the AGC amplifier 128 is controlled to optimize the input level of A/D converters 136 and 137 using C/N and a frequency difference in the AGC control section 141. The AGC control section 141 is realizable with a configuration as shown in drawing 14 here. Actuation of the AGC control section 141 is explained using drawing 14 . C/N is obtained by the C/N operation part 142 by the received power and signal power which were obtained first. C/N obtained here and the frequency difference acquired previously are inputted into the ROM table 143, and reference voltage is outputted so that it can control to the optimal A/D-converter input level. This reference voltage and signal power are measured and that comparison result controls the AGC amplifier 128 through the loop filter section 145.
[0067] Moreover, the control approach used for this example can exclude the detection section 135 like the point by not using the detection section, in case C/N is obtained like the 4th example applicable also to the 2nd example only by making the digital differential phase shift recovery section into the DQPSK recovery section, but computing by correlation peak value and its distribution. The AGC control section in this case can consist of forms where C/N operation part was excluded from the configuration of drawing 10 .
[0068] Moreover, it is applicable to this method using the technique of controlling the A/D-converter reference level used in the 5th example. The A/D control section in this case is realizable with a configuration as shown in drawing 11 .

[0069]
[Effect of the Invention] According to this invention, in a common direct diffuse-spectrum diffusion digital BPSK demodulator, the signal power detection section and the received-power detection section are prepared, receiving C/N is obtained, the A/D input amplitude is controlled to the optimal value, and the best error rate property can be realized with the value.
[0070] Moreover, the above-mentioned method is applicable also to QPSK, DPSK, and a DQPSK method.
[0071] Moreover, in the above-mentioned method, noise power is obtained from the distribution in the signal power detection section, receiving C/N is obtained from these values, and since the A/D input amplitude is controlled to the optimal value, the best error rate property can be realized, it compares previously and the received-power detection section can be excluded with the value, a miniaturization is more realizable.
[0072] Moreover, in a frequency phase simulation process, at the time of drawing in, it is at the prehension time and the optimal error rate property can be realized in every process by changing A/D-converter input amplitude level.
[0073] Moreover, the signal power detection section and the received-power detection section are prepared, receiving C/N is obtained, with the value, A/D-converter reference level is controlled to the optimal value, and the best error rate property can be realized.
[0074] Moreover, in a spread-spectrum digital demodulator which performs asynchronous differential detection, a means to get to know a frequency difference is established, an A/D-converter input level is controlled to the optimal value according to the frequency difference, and the best error rate property can be realized.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Industrial Application] This invention relates to amelioration of a direct diffuse-spectrum diffusion communication link receiving set.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Generally the communication link which used narrow-band modulation techniques (AM (amplitude modulation), FM (frequency modulation), BPSK (2 phase phase shift keying), QPSK (4 phase phase shift keying), etc.) is used for the conventional data communication. Although these can realize the recovery in a receiver in a comparatively small circuit, they also have the fault of being weak, by the multi-pass or the narrow-band noise.
[0003] on the other hand, by diffusing the frequency spectrum of data (an analog and digital one -- whichever is sufficient) with PN (pseudo noise: pseudo-random) sign, and taking this PN code and a time amount synchronization (correlation) by the receiver side, a spread-spectrum communication mode has the description of mitigating the effect of a multi-pass and a narrow-band noise, and attracts attention as an important technique at the transmitting side.
[0004] There is a hybrid system which combined some of direct diffusion, frequency hopping, time amount hopping, and these in the technique of spectrum spread system, and it is the technique of diffusing a spectrum because a direct diffusion method carries out the multiplication of a PN code with a chip rate quite quicker than a data rate, and the data in this, and can realize easily compared with the technique of the others also in circuit, and multiplex communication in the same frequency band is attained by distinction of a PN code. Such multiplex system is called CDMA (Code DivisionMultiple Access: code division point-to-multipoint connection) or SSMA (Spread Spectrum Multiple Access: spread spectrum multiple access).
[0005] Moreover, after carrying out frequency conversion to a baseband band generally, an analog / digital conversion (A/D conversion is called a sampling and henceforth) is carried out, and all signal processing may be performed by digital processing. Thereby, the miniaturization of the baseband section and simplification are attained. Moreover, a digital matched filter is used in this case in many cases.
[0006] The block diagram of the outline of the spread-spectrum communication system using a direct diffusion method and a digital recovery method is shown in drawing 8 and drawing 9 . Drawing 9 is concerned with a receiving system here, drawing 8 concerning a transmitting system.
[0007] A transmitting system is first explained using drawing 8 . + The exclusive OR of the binary transmit data sequence which is expressed with 1 or 0 is carried out by the PN code (+ binary-code sequence expressed with 1 or 0) and EX-OR80 which were first generated in the PN code generating section 79. the sine wave by which the sequence acquired by this was generated with the sine wave generator 81 with the multiplier 82, and multiplication -- a BPSK modulation is carried out. After this, frequency conversion of this sequence is carried out to RF band in the frequency-conversion section 83, and power amplification is carried out in the power amplification section 84, and it is transmitted from the transmitting antenna 85. Thus, in this example, the BPSK modulation is used as an information modulation. These actuation may be common and the common sending set for direct diffuse-spectrum diffusion communication modes may be used for it.
[0008] In a receiver side, as shown in drawing 9 , power amplification of the signal received by the receiving dish 86 is carried out by the RF amplifier 87, and it is changed into an intermediate frequency by the frequency-conversion section 88. Gain control of the signal changed into the intermediate

frequency is carried out so that it may be inputted by the AGC (Auto Gain Control: automatic gain control) amplifier 89 with the optimal amplitude for A/D converters 96 and 97. It is separated spectrally two times after this, and the multiplication of the sinusoidal signal by which one side was generated by the local sine wave signal generator 90, and another side is carried out to the signal by which the phase shift was carried out about 90 degrees with 90-degree phase vessel 91 in this sinusoidal signal with multipliers 93 and 92, respectively, they pass along low pass filters 95 and 94, respectively, and are digital-value-ized by A/D converters 97 and 96. Supposing it uses BPSK, QPSK, etc. for the information modulation here and carries out a synchronous detection by the receiver side further, it is supposed that what is necessary is this A/D converter just to be a triplet grade. Thus, correlation is taken by the digital matched filter sections 99 and 98, it gets over by the digital phase recovery section 100 using the peak value, and the digitized input signal obtains data, respectively.
[0009] Moreover, signal power (a signal component and total received signal power which united the noise) is obtained using a bi-phase Seki output, and the AGC amplifier 89 is controlled by the AGC control section 101 so that this value becomes fixed. This AGC control section is realized here in the circuit generally shown in drawing 8 . The signal power obtained by the correlation signal is measured with reference voltage by the differential amplifier section 102. Then, the control signal which integrates with this difference signal by the loop filter section 103, and controls the AGC amplifier 88 is generated. This loop formation operates in the direction which makes equal to reference voltage signal power obtained by the correlation signal.
[0010] Thus, a communication link will be performed by wide band width of face by diffusing a spectrum, and a more effective communication link is attained to a multi-pass or a narrow-band noise. Fine tuning of the recovery section becomes unnecessary by furthermore being digitized (quantization), and a configuration also has simple and the merit of being miniaturized.
[0011] The spread-spectrum communication mode is stated to "spread-spectrum communication system" p10-p16 of technology publishing company issue in detail.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, in a common direct diffuse-spectrum diffusion digital BPSK demodulator, the signal power detection section and the received-power detection section are prepared, receiving C/N is obtained, the A/D input amplitude is controlled to the optimal value, and the best error rate property can be realized with the value.
[0070] Moreover, the above-mentioned method is applicable also to QPSK, DPSK, and a DQPSK method.
[0071] Moreover, in the above-mentioned method, noise power is obtained from the distribution in the signal power detection section, receiving C/N is obtained from these values, and since the A/D input amplitude is controlled to the optimal value, the best error rate property can be realized, it compares previously and the received-power detection section can be excluded with the value, a miniaturization is more realizable.
[0072] Moreover, in a frequency phase simulation process, at the time of drawing in, it is at the prehension time and the optimal error rate property can be realized in every process by changing A/D-converter input amplitude level.
[0073] Moreover, the signal power detection section and the received-power detection section are prepared, receiving C/N is obtained, with the value, A/D-converter reference level is controlled to the optimal value, and the best error rate property can be realized.
[0074] Moreover, in a spread-spectrum digital demodulator which performs asynchronous differential detection, a means to get to know a frequency difference is established, an A/D-converter input level is controlled to the optimal value according to the frequency difference, and the best error rate property can be realized.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] If a digital recovery method is generally used, the circuits of the baseband section differ [simple and] in an error rate property very much by what level although miniaturized, A/D-converter input amplitude level is assigned to the maximum input electrical-potential-difference range of an A/D converter, and it is a signal power (power of only signal component) opposite noise power ratio (a C/N ratio is called henceforth.) before the optimum value correlating further. here -- the C/N ratio before the back diffusion of electrons -- expressing -- it differs, and the optimum value of A/D-converter input amplitude level becomes low, so that it will become low, if a C/N ratio becomes low. Therefore, even if it controls receiving signal amplitude only by the correlation peak signal, the optimal property has the trouble of not being obtained.
[0013] Moreover, in a frequency synchronization process, it is at the frequency drawing-in and prehension time, the optimum values of A/D-converter input amplitude level also differ, and the optimum value of A/D-converter input amplitude level has the trouble of becoming low, compared with the time of frequency prehension at the time of frequency drawing in.
[0014] Moreover, in having a frequency difference between transmitter-receivers which use differential detection etc., the optimal A/D-converter input amplitude level has the trouble that such optimal A/D-converter input amplitude level that a frequency difference is generally large in things becomes large, according to the frequency difference.
[0015] This invention aims at optimizing quantization level of an A/D converter in a direct diffuse-spectrum communication mode and a communication device.

[Translation done.]

MEANS

[Means for Solving the Problem] The input signal sampled and the A/D converter which quantizes, a means get to know received power, the quantized digital value and the digital matched filter section which takes correlation, and the amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter and the AGC control section which generates a gain control signal so that said A/D converter input amplitude level may be further optimized using the correlation peaking capacity of said matched filter and said received power, and controls an AGC amplifier constituted in the recovery method of this invention.
[0017] Moreover, the A/D converter which quantizes by sampling an input signal, and the quantized digital value and the digital matched filter section which takes correlation, The amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter, and the frequency synchronizer which computes a frequency control signal using the correlation peaking capacity of said matched filter further, and performs frequency synchronization, The gain control signal was generated so that said A/D-converter input amplitude level might be optimized based on a distinction means to judge frequency synchronization establishment, and its distinction result, and the AGC control section which controls an AGC amplifier constituted.
[0018] Moreover, it had a means to get to know noise power and signal power, and the frequency synchronization establishment distinction means, the gain control signal was generated so that A/D-converter input amplitude level might be optimized using both sides, and the AGC control section which controls an AGC amplifier constituted.
[0019] Or the input signal was sampled and the A/D converter which quantizes, a means to get to know received power, the quantized digital value and the digital matched filter section which takes correlation, the AGC (automatic gain control) amplifier that sets in the preceding paragraph and sets A/D-converter input power more nearly constant than an A/D converter, and the A/D control section controlled to optimize the reference level of said A/D converter using the correlation peaking capacity of said matched filter and said received power further constituted.
[0020] Or it had a means to get to know noise power and signal power, and the frequency synchronization establishment distinction means, and the A/D control section controlled to optimize the reference level of an A/D converter using both sides constituted.
[0021] Or the A/D converter which quantizes by sampling an input signal, and the quantized digital value and the digital matched filter section which takes correlation, The amplifier for AGC (automatic gain control) set in the preceding paragraph from the A/D converter, and a delta-frequency calculation means to generate the signal according to a delta frequency in case a differential recovery is further performed using the correlation peaking capacity of said matched filter, The gain control signal was generated so that said A/D-converter input amplitude level might be optimized based on the calculation result, and the AGC control section which controls an AGC amplifier constituted.
[0022] Or the input signal was sampled, and the A/D control section constituted so that the reference level of said A/D converter might be optimized based on the A/D converter which quantizes, the quantized digital value and the digital matched filter section which takes correlation, the AGC amplifier

set in the preceding paragraph from the A/D converter, a frequency difference calculation means to generate the signal according to a delta frequency in case a differential recovery is further performed using the correlation peaking capacity of said matched filter, and its calculation result.
[0023] Or it had a means to get to know noise power and signal power, and the frequency difference calculation means, and the A/D control section controlled to optimize the reference level of an A/D converter using both sides constituted.
[0024] Moreover, it had a means to get to know noise power and signal power, and the frequency difference calculation means, the gain control signal was generated so that A/D-converter input amplitude level might be optimized using both sides, and the AGC control section which controls an AGC amplifier constituted.

[Translation done.]

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OPERATION

[Function] According to this invention, it amplifies, and frequency conversion of the input-signal s (t) is carried out, and it has an AGC amplifier let it pass after that. Then, the multiplication of the local sine wave signal which intersects perpendicularly mutually is carried out, and an inphase and a rectangular baseband component are generated. Both [these] baseband signaling is digitized by one pair of A/D converters after this. Moreover, received power is obtained from both baseband signaling. Moreover, while correlation is taken by the digital matched filter and signal power is obtained from the bi-phase Seki peaking capacity, in the digital phase recovery section, a recovery is made using bi-phase Seki peaking capacity, and, as for both the signals by which the **** was digitized, data are obtained. Moreover, a best error rate property is realizable by controlling an above-mentioned AGC amplifier using the received power and signal power which were obtained previously to make an A/D-converter input level the optimal.
[0026] Moreover, a frequency synchronization detector is prepared and it detects whether frequency synchronization was performed here, and it is at the frequency drawing-in and frequency prehension time, an A/D-converter input level is changed, and the always optimal error rate property is realized.
[0027] Or the input power to an A/D converter is set constant by the AGC amplifier, and the same result is obtained by controlling the reference level of an A/D converter by the received power obtained previously and signal power.
[0028] Moreover, it is asynchronous, and when getting over, correlation is taken by the digital matched filter, a recovery is made by differential detection etc. in the digital phase recovery section from the bi-phase Seki peaking capacity, and data are obtained. Furthermore, the value according to the frequency difference between transmitter-receivers is acquired using these bi-phase Seki peak, and optimization or the reference level of an A/D converter is controlled for an A/D-converter input level according to it.
[0029] Or a best error rate property is realizable using together C/N obtained by the received power obtained previously and signal power by controlling control or the reference level of an A/D converter for an above-mentioned AGC amplifier to make an A/D-converter input level the optimal.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the transmitting system outline block diagram of the 1st example concerning this invention.
[Drawing 2] It is the receiving system outline block diagram of the 1st example concerning this invention.
[Drawing 3] It is the block diagram of the AGC control section in the 1st example concerning this invention.
[Drawing 4] It is the transmitting system outline block diagram of the 2nd example concerning this invention.
[Drawing 5] It is the receiving system outline block diagram of the 3rd example concerning this invention.
[Drawing 6] It is the receiving system outline block diagram of the 4th example concerning this invention.
[Drawing 7] It is the block diagram of the AGC control section in the 4th example concerning this invention.
[Drawing 8] It is a transmitting system outline block diagram concerning the conventional direct diffuse-spectrum diffusion communication mode.
[Drawing 9] It is a receiving system outline block diagram concerning the conventional direct diffuse-spectrum diffusion communication mode.
[Drawing 10] It is the block diagram of the AGC control section in the receiving system concerning the conventional direct diffuse-spectrum diffusion communication mode.
[Drawing 11] It is the receiving system outline block diagram of the 5th example concerning this invention.
[Drawing 12] It is the block diagram of the A/D control section in the 5th example concerning this invention.
[Drawing 13] It is the receiving system outline block diagram of the 6th example concerning this invention.
[Drawing 14] It is the block diagram of the AGC control section in the 6th example concerning this invention.
[Drawing 15] It is the block diagram of the A/D control section in the 6th example concerning this invention.
[Description of Notations]
1, 32, 79 PN code generating section
2, 30, 31, 80 EX-OR section
3, 35, 81 Criteria subcarrier generating section
4, 12, 13, 33, 34, 45, 46, 67, 68, 82, 92, 93,110,111,131,132 multipliers
5, 10, 38, 43, 65, 83, 88,106,127 Frequency-conversion section
6, 39, 84 Power amplification section

7, 40, 85 Transmitting antenna
8, 41, 63, 86,104,125 Receiving antenna
9, 42, 64, 87,105,126 RF amplifier
11, 44, 66, 89,107,128 AGC amplifier
14, 47, 69, 90,108,129 Criteria local sine wave generating section
15, 48, 70, 91,109,130 90-degree phase machine
16, 17, 49, 50, 71, 72, 94, 95, 112, 113, 133 134 Low pass filter
18 51,114,135 Power detection section
19, 20, 52, 53, 73, 74, 96, 97, 115, 116, 136 137 A/D converter
21, 22, 54, 55, 75, 76, 98, 99, 117, 118, 138 139 Digital matched filter
23, 56, 77,100,119,140 Digital phase recovery section
24, 58, 78,141 AGC control section
54 Synchronous Check Section
25 59,121,142,146 C/N operation part
26 60,122,143,147 ROM table section
27 61,102,144 Differential amplifier section
28 62,103,145 Loop filter section
120 A/D Control Section
123, 124, 148, 149 D/A converter section

[Translation done.]

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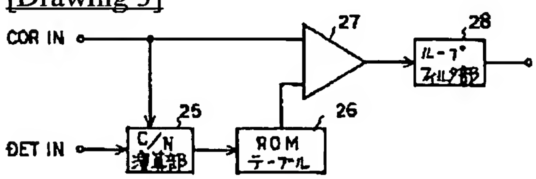
3.In the drawings, any words are not translated.

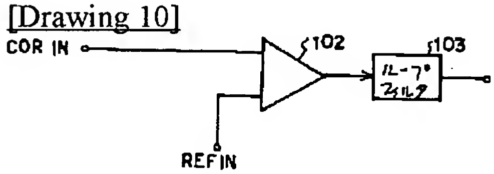
DRAWINGS

[Drawing 3]

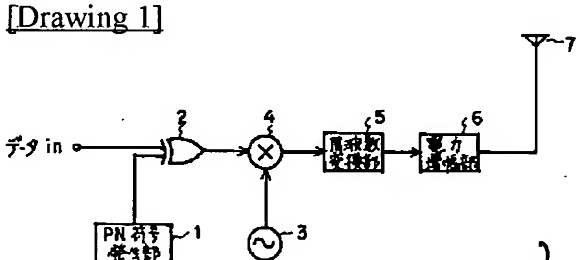


28: loop filter

[Drawing 10]

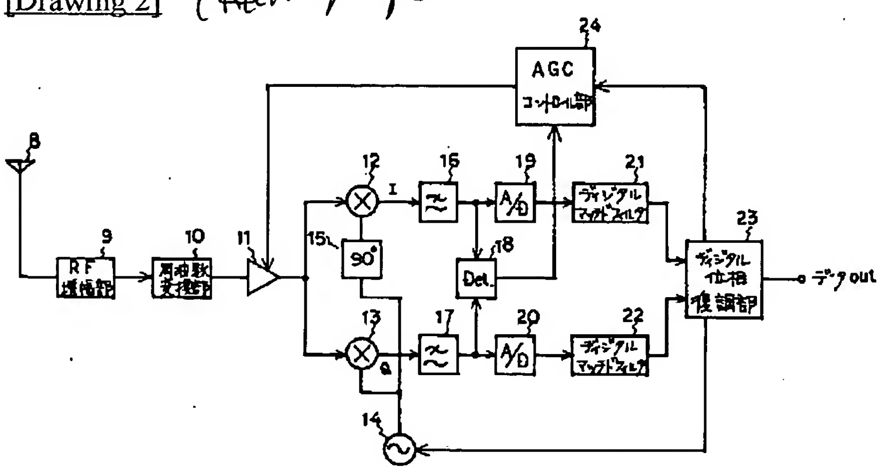


[Drawing 1]



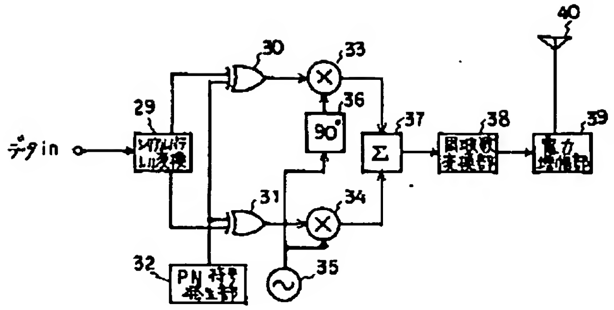
9: RF Amplifier
10: Frequency Conversion
11: amplifier (AGC)

[Drawing 2] (Recovery System)

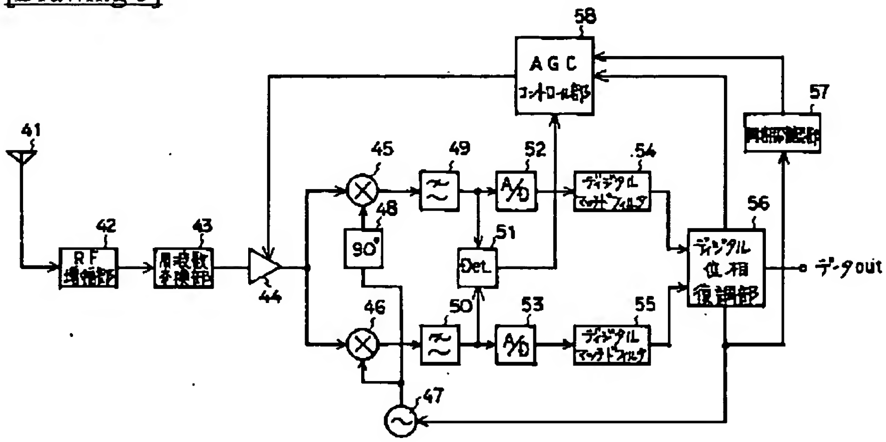


14: Sine wave signal oscillator
16/17: LPF
18: detector part
24: AGC control part
19/20 : A/D
21/22: Digital match filter

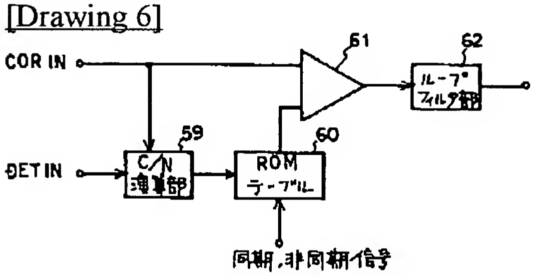
[Drawing 4]



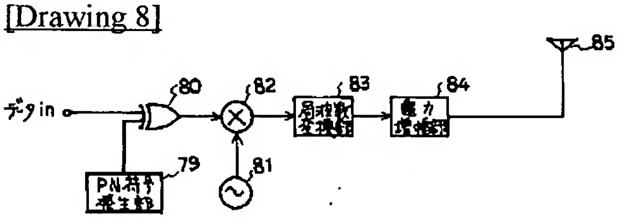
[Drawing 5]



[Drawing 6]

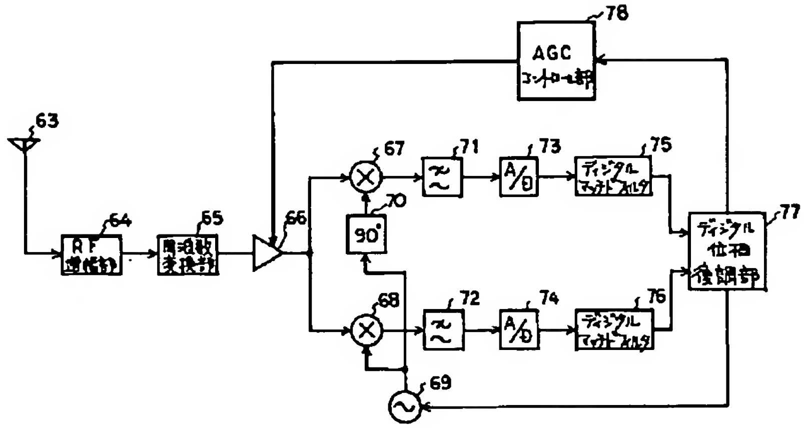


[Drawing 8]

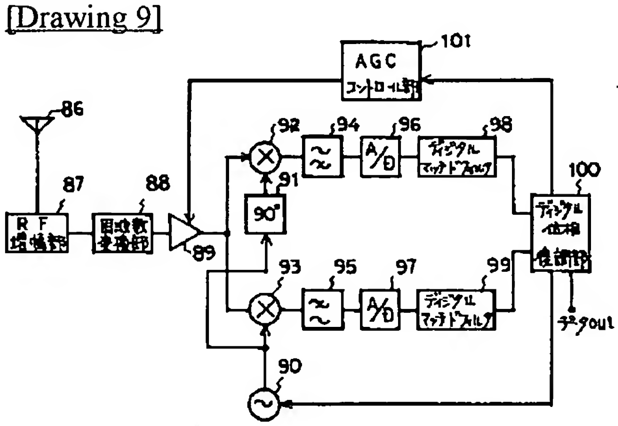


[Drawing 7]

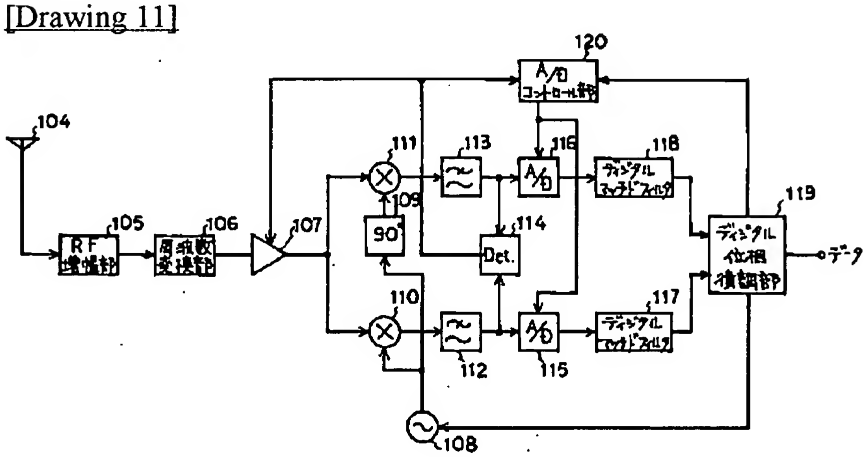
h c g cg b eb cg e e



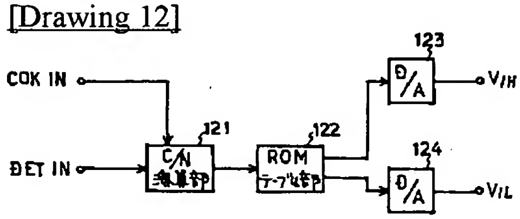
[Drawing 9]



[Drawing 11]

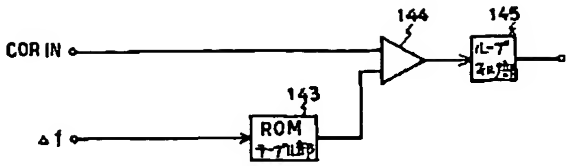


[Drawing 12]

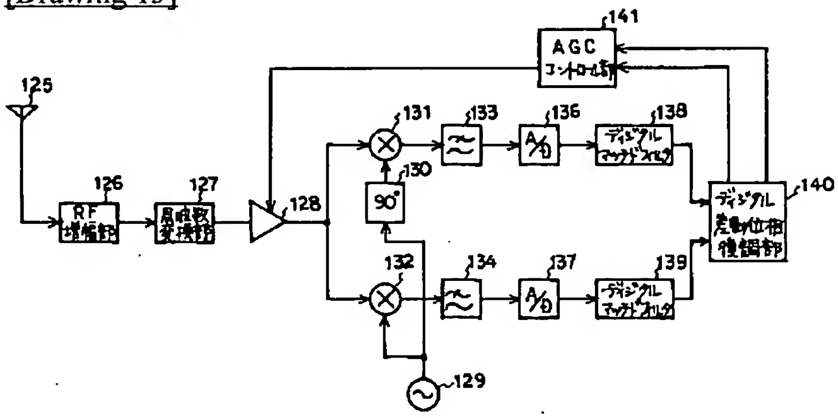


[Drawing 14]

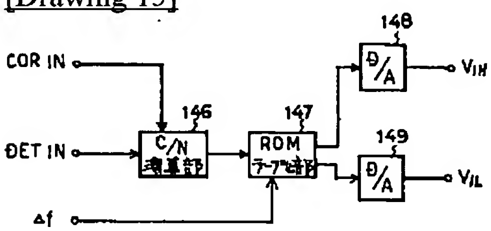
h c g cg b eb cg e e



[Drawing 13]



[Drawing 15]



[Translation done.]

h c g cg b eb cg e e